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ABSTRACT

While mnemonic systems have been taught and used for hundreds of years, virtually all of the experimental research into such systems has been conducted since 1965. This paper describes four mnemonic systems, all of which rely heavily on visual imagery, and summarizes research conducted on the performance values of each system. The link system, the simplest of the systems, aids serial recall by associating items with each other in a chain of associations. The loci system, the most ancient of the systems, aids recall by associating items with prememorized mental images of locations. The peg system aids recall by associating items with a prememorized series of concrete nouns (pegwords). The phonetic system, the most complex, substitutes consonant sounds for digits, to allow for coding numbers into words and for constructing extensive lists of key words to be used in the same manner the loci and pegwords are used. The paper concludes that mnemonic systems can make enough of a contribution to memory to warrant their mastery and use and that research into such systems should be continued.
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Mnemonic Systems in Memory: Are They Worth the Effort?

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The word mnemonic means "aiding the memory," and mnemonics refers in general to methods of memory improvement. Typically, however, the term mnemonics is used to refer more specifically to rather unusual, artificial memory techniques, of the kind recommended in popular memory-training books. These would include such techniques as visual imagery, verbal mediators, stories, rhymes, acrostics, and acronyms. This paper discusses mnemonic systems, as opposed to specific-purpose mnemonic techniques. A mnemonic system may be viewed as a mental filing system, and can be used over and over to learn different kinds of material.

My interest in mnemonics dates back about 20 years to the time I first read a popular memory-training book. A few years ago, I developed a university course which I entitled, "Understanding and Improving Your Memory." Part of the course deals with the use of mnemonic systems. I have just completed a book on memory improvement, which will be published at the first of next year (if all goes well). The book includes descriptions of mnemonic techniques and systems, their strengths and limitations, research evidence as to how well they work, and suggestions as to how they can be used. This paper is condensed from material prepared for the book.

During the first half of this century, mnemonic systems were widely taught in popular memory books and commercial courses, used by mnemonists and some laymen, and ignored by most psychologists. Renewed research interest in mnemonics during the 1960's accompanied the return of cognitive processes (particularly visual imagery) as an acceptable area of research. Virtually all of the experimental research on mnemonics has been conducted since 1965, and most of that since 1970 (see Higbee, 1976a).

Textbooks on learning frequently dismiss mnemonic systems with a brief comment, and a statement to the effect that they are interesting oddities, but are not worth the effort it takes to learn and use them. The purpose of this paper is to consider whether mnemonic systems are worth the effort it takes to learn them, and the effort expended by psychologists to conduct research on them. The paper discusses research

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evidence on how well the systems work rather than discussing how the systems can be applied in practical learning tasks; practical applications of the systems are suggested in popular memory-training books (e.g., Lorayne & Lucas, 1974). Four mnemonic systems are discussed: The Link System, the Loci System, the Peg System, and the Phonetic System. Each system is described, then research on it is briefly summarized.

The Link System

The Link, or Chain, System is the most elementary of the mnemonic systems. In fact, it may really be too simple to accurately be called a "system." The Link System, which is appropriate for serial learning tasks, consists of two steps. First, form a visual image for each item in the list to be learned. Second, associate the image for each item with the image for the next item. (Although all mnemonic systems discussed in this paper rely heavily on visual imagery, they can also be used with verbal mediators--Foth, 1973.) Thus, you form a visual association between the first two items, then between the second and third items, then between the third and fourth items, and so on. The reason for the name of this system should be obvious--the items are linked together to form a chain of associations.

For example, suppose that a person were given a list that begins with the following five items: Paper, tire, doctor, rose, ball. To use the Link System in remembering these five items, he would first form a visual association relating paper and tire. You might picture a car driving on paper tires, or yourself using a tire to erase writing from a paper. Next, associate tire and doctor. You might picture a tire running over a doctor, or a tire performing an operation. To associate doctor and rose, you might picture a doctor operating on a rose, or a doctor giving roses to a patient. To associate rose and ball, you might picture two people playing catch with a rose, or balls growing on a rose bush.

The above examples vary in bizarreness. Contrary to what most popular memory books emphasize, research evidence indicates that it is not necessary for images to be bizarre in order to be memorable, as long as they are vivid and involve interaction among the items being associated (cf., Higbee, 1976a).

To recall a list learned by the Link System, you begin with the first item, and proceed in order as each item leads to the next one.

A method that is a variant of the Link System is the Story System, in which the items are woven into a connected story. The Story System is an extension of the use of sentences as mediators in a paired-associate task; you just continue with additional sentences to form a story based on the items to be remembered. For example, one might use something like the following for the previous 5-item list: The paper boy rolled a

tire down the sidewalk, and it hit the doctor coming to make a house call (now that's a bizarre idea!). It knocked him into a rose bush, and he picked up a ball and threw it at the boy.

Although the Story System is similar to the Link System, there are at least four differences. First, in the Link System each pair of items is associated independent of the previous links, while in the Story System the items are associated in a continuous, integrated, sequence. This logical sequence is an advantage of the Story System over the Link System for some people, who find it easier to recall a story than a series of unrelated associations. Second, the Story System may require a little more time to make each association than the Link System does, because one must think of an association that fits the narrative of the story, rather than using the first association that comes to mind. A third difference is that the longer the list, the harder it is to work each succeeding item into an integrated story. Most people find it very hard to put together a 20-word story to remember a list of 20 items (Bugelski, 1974); but, it is not much harder to use the Link System on a list of 20 items than on a list of 10 items. Fourth, items learned by the Link System can be recalled in backwards order almost as well as forwards; but items weaved into a story may be harder to recall backwards.

Research on the Link System

Delin (1969a, 1969b, 1969c) has conducted several studies on the Link System, instructing college students to learn lists of words by linking the items together with bizarre imagery. The Link System helped people learn the lists faster and make fewer errors in recall. Bugelski (1974) read a 20-word list once to college students and eighth-graders. The college students who used the Link System recalled an average of three times as many words in order as did the students who did not use a system (15 vs. 5); for the eighth-grade students the ratio was about two-to-one (11 vs. 6). In addition, 15-25% of the Link students recalled all 20 words in order after hearing them only once. Other studies have also found that linking items together using visual imagery aids serial memory (Muelier & Jablonski, 1970; Wood, 1967).

Even more striking results have been found for the Story System. Bower and Clark (1969) presented 12 different lists of 10 words each during a period of 30-40 minutes. Some people used the Story System to learn the lists and others were left to their own resources. After all 12 lists were presented, recall was tested by giving the first word of each list and requiring recall of the other items in order. The Story group recalled about seven times as much as the other students (93% vs. 13%). Other studies have also found that the Story System can make a significant contribution to serial learning of word lists (Boltwood & Blick, 1970; Manning & Bruning, 1975; Murray, 1974).

Of all the mnemonic systems discussed in this paper, the Story System is probably the most frequently used spontaneously by people not trained in mnemonics. When people were asked what aids they might use in learning a list of words, only 6% of them reported that they would use a story (Blick & Waite, 1971), but when people were actually given a list of words to learn, 22% used a story (Boltwood & Blick, 1970). Roberts (1968) found that when people were given the task of remembering a series of words, three-fourths of them reported that they sometimes grouped words in "strings," by creating mental pictures or formulating stories.

I frequently use the Link System to help students demonstrate to themselves the power of visual association, because I can explain the system to them in about five minutes and let them try it. First I read to them a list of 20 concrete nouns to remember, and have them write as many as they can recall in order. Then I explain the Link System. Finally, I read to them a second list of 20 concrete nouns to remember using the Link System, and have them recall as many as they can in order. Very few people recall all 20 words from the first list (those that do generally use some kind of mnemonic technique). However, after learning the Link System, about half of the students generally recall all 20 words from the second list. Many of them are astounded at their own performance.

For example, I conducted this demonstration in a general psychology class when we were discussing learning and memory. On the first 20-word list, the class recalled an average of about 12 words (only eight of 41 students recalled at least 18 words, and only two recalled all 20 words). Using the Link System, the class recalled an average of about 18 words on the second list (30 students recalled at least 18 words, and 20 students recalled all 20 words). Such results are more striking than those found in some research studies, probably because of procedural differences (for example, I give the students about 10 seconds per word, a little slower presentation-rate than is used in most research studies; and the demonstration involves a within-group comparison, whereas most research studies use between-groups comparisons).

The Loci System

One limitation of the Link System stems from the fact that each item is associated with the previous item--thus, forgetting one item affects memory for subsequent items. The Loci System does not have that limitation. In the Loci System one builds up a mental file of previously-memorized images with which new information can be associated. Thus, the Loci System fits the analogy of a mental filing system better than does the Link System.

The Loci System, which is also called the Topical System, is the most ancient mnemonic system, dating back to about 500 B.C. It was the

mnemonic system until about the middle of the 17th Century, when other systems such as the Peg and Phonetic Systems discussed in subsequent sections began to evolve. Frances Yates (1966) has traced the history of the Loci System in detail from the ancient Greeks through the 17th century, and Yates' book is recommended for anyone interested in the history of mnemonics.

The word loci is the plural of locus, which means "place or location." Thus, the Loci System is the system which uses places or locations. The Loci System consists basically of two steps. First, memorize (overlearn) a series of mental images of familiar locations in some natural or logical order. Second, associate a visual image of each item to be remembered with a location in the series; do this by placing the items, in the order they are to be remembered, in the locations as you take an imaginary walk past the locations. Locations have an advantage of being concrete (thus easy to visualize), and of being learned in a natural serial order.

The series of locations is the mental filing system, which is used over again for each new list of items. This is an important feature, because the system would hardly be worth the effort if you had to memorize a new set of locations every time you wanted to memorize a new list of items; you would just have twice as much to remember.

Let us consider an example. Picture in your mind each of the following locations in a house with which you are very familiar. The first location is the front walk that leads up to the house. The second location is the front porch. The third location is the front door. The fourth location is the coat closet where you hang your coat after entering the house (or the corner where you throw it). The fifth location is the next logical place, the refrigerator.

Now, suppose you want to use these locations to remember the same five items discussed previously: Paper, tire, doctor, rose, and ball. You might proceed as follows: Associate paper with your front walk; you might see it made of paper (which you can hear crinkling under your feet as you walk on it), or see your newspaper coming down the walk to meet you. Associate tire with porch; you might see tires rolling off your porch or see your porch made of tires. Associate doctor with door; you might see a doctor hanging on the doorknob, or stuck in the doorway. Associate rose with front closet; you might see the closet completely empty except for a rose bush growing from the shelf, or see a large red rose hanging from a coat hanger. Finally, associate ball with refrigerator; you might see your refrigerator in the shape of a giant ball, or hundreds of balls rolling out of the refrigerator when you open the door.

Now take a mental talk through these five locations and try retrieving the five items. You will probably find this task to be quite easy. The Loci System enables you to change what is essentially a free-recall task

to make recall easier. The task incorporates paired-associate learning, with the location serving as the stimulus word in each pair and the item serving as the response word. The task also incorporates serial learning, because the locations are organized in a natural serial order.

Like the Link System, the Loci System aids in recalling all the items in a list, and remembering them in correct order. One limitation of both the Link and Loci Systems is that they do not enable direct retrieval of an item at a particular position on a list. For example, to find the twelfth item in the Link System, you must proceed through your links until you reach the twelfth item. Likewise, as is noted in the next section, a mental walk through a series of loci is also a step-by-step process, in which the loci are identified one at a time. Thus, for the Loci System you must walk through your mental locations until you reach the twelfth location, then retrieve the item from the location.

Research on the Loci System

Anciently it was recommended that the locations be widely spaced. However, it appears to be more important for the loci to be distinct than it is for them to be distant, at least with respect to retrieval time. Lea (1975) had college students learn a list of 12 concrete words using 12 campus buildings as loci. He then named various locations, one at a time, and measured the time required to find a location that was either one, two, or three positions away from the named location. The search time was not related to the actual physical distances between the loci, but was linearly related to the number of loci covered. This finding indicates that people do not skip over loci to get directly to the desired one, but process the intervening loci one at a time, step-by-step (the same way in which one goes through his chain of associations serially using the Link System). Additional characteristics of the Loci System have been analyzed in considerable detail by Gordon Bower (1970).

The Loci System is based on the assumption that memory for locations will aid memory for the events associated with those locations. A number of studies have found a positive correlation between memory for location of material and memory for the content of the material, suggesting the possibility that location memory may aid content memory (e.g., Byrne, 1974; Schulman, 1973; Von Wright, Gebhard, & Karttunen, 1975; Zechmeister, McKillip, Pasco, & Bespalec, 1975). Similarly, remembering where we have seen a person may help us recall the person's name (cf., Read & Peterson, 1975; Yarmey, 1973). Even children can use locations to aid memory (Brown, 1973; Kobasigawa, 1975).

The above research on using memory for location of material to aid memory for the content of the material provides indirect supportive evidence for the Loci System. Direct evidence that the Loci System can significantly improve memory has been provided in studies by Ross and Lawrence (1968), Bower (1973), and Groninger (1971, 1974).

Whereas most studies have used a between-groups design, one study which used a within-group design also found the Loci System to significantly aid memory (McKellar, Marks, & Barron, 1972).

Studies by Herbert Crovitz have suggested that a person does not need to memorize locations in order to use them, but can simply use a printed list of locations (Crovitz, 1969); however, a list of loci helps people only when they are trained in using visual associations (Crovitz, 1975). In addition, it may not be necessary that the location-item associations be constructed by the learner (Briggs, Hawkins, & Crovitz, 1970)--although most research has found that associations constructed by the learner are more effective than associations provided by the experimenter (see Higbee, 1976a).

The Peg System

It has been noted that direct retrieval of an item at a certain position in a memorized list (for example, the 12th item) is difficult for both the Link and Loci Systems. They are both dependent on sequential retrieval. The Loci System associates items to be learned with pre-memorized cues (locations). To use that same approach in a way that will enable direct retrieval of a given item, you might associate items to cues that you already have memorized, and know very well--the number sequence. If you could associate the first item with number 1, the second item with number 2, and so on, then you could just recall what item was associated with each number. If you want to retrieve the 12th item directly, you would think of number 12 and see what item is associated with it. The main problem with this strategy is that numbers are abstract, and thus are hard to associate with items. But the strategy would be feasible if a way could be found to make the numbers concrete, or to substitute something concrete for the numbers. This is what the Peg System does.

The Peg System is a mental filing system consisting of a series of pre-memorized concrete nouns. The concrete nouns are not randomly selected, but are selected to correspond with numbers. The Peg System can be traced back to the mid-seventeenth century, when Henry Herdson developed an extension of the Loci System; he dispensed with the spatial locations of the objects, and merely used the objects themselves as cues. Each digit was represented by any one of several objects which resemble the numbers (for example, 1 = candle; 3 = trident; 8 = spectacles; 0 = orange).

A system which used rhyming syllables and words to represent the numbers was introduced in England around 1879 by John Sambrook (Paivio, 1971). The nouns rhymed with the numbers they represented to aid in remembering what noun represented each number. The following is a widely-used version of the Peg System based on rhymes, indicating the word which represents each number:

one-bun	six-sticks
two-shoe	seven-heaven
three-tree	eight-gate
four-door	nine-wine
five-hive	ten-hen

The Peg System gets its name from the fact that the pegwords serve as mental pegs, or hooks, on which the person "hangs" the items to be remembered. To use the Peg System to learn new material, you associate the new material with each of the pegwords in order. For example, the first five pegwords could be used to learn the list used to illustrate the Link and Loci Systems--paper, tire, doctor, rose, ball--as follows: Associate paper with bun; perhaps see yourself eating a bun made of paper, or reading the evening newsbun. Associate tire with shoe; perhaps see yourself wearing tires on your feet, or see a car that has four shoes in the place of tires. Associate doctor with tree; see a doctor operating on a tree, or a doctor climbing a tree. Associate rose with door; see a rose in the place of the door knob, or a rose bush growing from the middle of the door. Associate ball with hive; see a round beehive in the shape of a ball, or balls rather than bees flying out of the hive.

One limitation of the Peg System is that it is difficult to find good pegwords to represent numbers beyond ten. It is hard to find words, for example, that rhyme with twenty-four or thirty-seven. Only one research study of which I am aware used pegwords to represent the numbers from 11-20 (Bower & Reitman, 1972); the pegwords did aid memory, but are not as satisfactory as the pegwords for 1-10.

The rhyming Peg System just described is one that is commonly used, and is the one on which the most research has been done, but actually there are a number of Peg Systems. They all have in common the characteristic of using a concrete object to represent each number, but there are various ways to choose the object to represent each number. The system discussed thus far uses pegwords that rhyme with the numbers. Other rhymes have been used--for example, one-gun, four-core, eight-plate, ten-pen. Pegwords which represent objects that look like the numbers can also be selected--for example, one-pencil, two-swan (the curve of the neck resembling a two), eight-hourglass, and ten-knife and plate. Pegwords can be selected on the basis of meaning also--for example, one-me (there's only one me), three-pitchfork (three prongs), five-hand (five fingers), nine-baseball (nine men on a team). Peg Systems have also been based on the alphabet, using rhyming pegwords (e.g., A = hay, B = bee, C = sea, etc.), or pegwords beginning with each letter (e.g., A = apple, B = boy, C = cat, etc.).

Peg and Loci Compared

There are a number of similarities between the Peg System and the Loci System, and performance has been found to be equivalent for the two systems (Bower & Reitman, 1972). The following are four similarities:

1. The Peg System is similar to the Loci System in that items to be learned are associated with previously-memorized concrete items. These previously-memorized items make up the mental filing system to which new items are attached. The pegwords are used in the same way that locations are used in the Loci System.

2. In the Peg System, the mental filing system consists of a series of concrete nouns rather than of locations, but locations are merely objects that are spatially ordered. For example, the five loci used in the previous example were a sidewalk, a porch, a door, a closet, and a refrigerator.

3. As with the Loci System, the Peg System changes a free-recall task to a paired-associate task, with the peg words serving as the stimulus word in each pair. Thus, the Peg System and the Loci System are a kind of paired-associated learning where the learner generates his own stimulus words rather than having them given to him by someone else.

4. The Peg System and the Loci System have several advantages over free-recall. First, the learner has a definite and consistent learning strategy; he knows exactly what to do with each item as he studies it (that is, associate it with a location or pegword). Second, he has definite pigeon-holes (pegwords or locations) into which to file the items. Third, he has a systematic retrieval plan telling him where to begin recall, how to proceed systematically from one item to the next, and how to monitor the adequacy of his recall (he can tell how many items he has forgotten, and which ones). Thus, the systems overcome one of the major problems in free recall--how to remind yourself of all the things you are supposed to recall (Bower, 1972a).

Although the Peg and Loci Systems are similar, there are also at least two significant differences between the two systems. First, as has been noted, the Peg System has the advantage of permitting direct retrieval. If you want to know what the eighth item was without going through the first seven, you merely think of "gate" and see what is associated with it. Second, the Loci System has the advantage of allowing a large number of mental images to make up the mental filing system--there is really no limit on the number of locations you can use, but it is difficult to find a large number of pegwords which rhyme with or look like numbers larger than 10, and especially larger than 20.

Research on the Peg System

People using the Peg System typically recall a list of 10 words correctly, in order, after hearing them once. People not using the system typically recall about half as many (Bugelski, 1970). In general, concrete words are learned slightly better than abstract words with the Peg System, but abstract words are still learned readily by using concrete "substitute words" (Bugelski, 1970; Wood, 1967).

Experiences reported by Hunter (1964) may serve to typify the effectiveness of the Peg System. Hunter read a list of 10 numbered words to a group of 32 college students who had been taught the Peg System, and to 32 other students who had not been taught the Peg System. They recalled the words, and wrote them after the appropriate numbers. The students who had not been taught the Peg System recalled an average of less than 7 words, with only two students (6%) recalling all 10 words. However, the students who used the Peg System recalled an average of more than 9 words, with 17 students (53%) recalling all 10 words.

Hunter reported that he has used the Peg System with more than 800 students, with different lists, and the use of the system never fails to improve the recall of most students--often to the surprise of the students themselves. He noted that when a few students do not benefit from the system, it is usually because either they decide privately not to use it, or they cannot resist recalling earlier items while later items are still being presented to them.

A number of experimental studies have also provided evidence that the Peg System can make a significant difference in recall of a single list of words (cf. Bower, 1972b; Bugelski, Kidd, & Segmen, 1968; Wood, 1967) and in recall of multiple lists of words (Bugelski, 1968). Alphabet pegwords have also yielded astonishing scores as compared with controls (Bugelski, 1970). Pegwords can also aid memory in young children (Higbee, 1976b; Russell, 1974).

The pegwords in most studies are concrete. Could abstract pegwords be used? Paivio's (1971) "conceptual peg" hypothesis, which suggests that in paired-associate lists it is more important that the stimulus word be concrete than that the response word be concrete, suggests that abstract pegwords would not be effective. However, the evidence on this issue is not consistent. Paivio (1968) reported that a variation of the Peg System using abstract pegwords (e.g., one-fun, two-true, three-free) was as effective as a Peg System using concrete pegwords. However, a later study that tried to duplicate this finding found that the concrete pegwords aided recall more than did the abstract pegwords; people who used abstract pegwords did not recall any better than people who did not use any pegwords (Delprato & Baker, 1974). The results of this second study indicate that concreteness of pegwords is critical in the Peg System. A third study found that whether concrete pegwords or abstract pegwords are more effective depends on the visual imagery ability of the user (DiVesta & Sunshine, 1974).

The Phonetic System

The system I call the Phonetic System has been referred to by such terms as "figure-alphabet," "digit-letter," "number-alphabet," "Hook," "number-consonant," and "number-to-sound". Of these many labels, the

most descriptive is the last one, the "number-to-sound" system. The other labels are more descriptive of older versions of the system. The reason why I have chosen to call the system the "Phonetic System" will become clear as it is described.

The Phonetic System may be viewed as a type of Peg System. However, it is unique enough to warrant separate discussion. The Phonetic System is the most sophisticated and most versatile of the four mnemonic systems. It is also the most complex, and thus requires the most study and effort to master. However, for use as a mental filing system, the Phonetic System overcomes a limitation of the Peg System by allowing construction of more than 10-20 pegwords. At the same time, it retains the Peg System's advantage of direct retrieval. In addition, the Phonetic System enables one to make numbers meaningful so that they can be better remembered by association. In the Phonetic System, each of the digits from 0-9 is represented by a consonant sound; these consonant sounds are then combined with vowels to code numbers into words.

The origin of the Phonetic System can be traced back over 300 years to 1648, when Winckelman (also spelled, "Wenusheim," or "Wennsshein" by some) introduced a digit-letter system in which the digits were represented by letters of the alphabet. These letters were then used to form words to represent a given number sequence. In 1730 Richard Grey published a refinement of Winckelman's digit-letter system.

In these early systems the digits were represented by both consonants and vowels, and the letters selected to represent each digit were selected arbitrarily. In 1813 Gregor von Feinaigle (Feinaigle, 1813) described a further refinement of the system. In Feinaigle's system the digits were represented by consonants only; vowels had no numerical value. In addition, the consonants representing each digit were not selected arbitrarily, but were selected on the basis of their similarity to, or association with, the digits they represented (for example, "t" = 1 because it resembles a "1", "n" = 2 because it has two downstrokes, "d" = 6 because it resembles a reversed "6"). Words were then formed to represent numbers, by inserting vowels; thus, "6" could be represented by "aid," and "16" could be represented by "tide."

Further modifications of the digit-consonant system were made by mnemonists during the 1800's. By the end of the nineteenth century, the system had evolved into its present form. The digits were represented not just by consonants, but by consonant sounds. This is why I have chosen to call the system the "Phonetic System." This version of the system, described briefly by William James in his classic general psychology textbook (James, 1890), has remained essentially unchanged in memory books and commercial courses during the twentieth century. The basis of the Phonetic System is summarized in Table 1.

Table 1

The Phonetic System

Digit	Consonant Sound	Memory Aid
1	t, d, th	"t" and "d" each have one downstroke
2	n	two downstrokes
3	m	three downstrokes
4	r	last sound for the word "four" in several languages
5	l	Roman numeral for "50" is "L"
6	j, sh, ch, soft "g"	reversed script "j" resembles "6" (ɾ)
7	k, q, hard "c," hard "g", ng	"7" resembles a skeleton key (ㄱ); "k" made of two 7's (K)
8	f, v, ph	script "f" resembles "8" (ℱ)
9	b, p	both resemble "9" when inverted
0	z, s, soft "c"	"Z" = "zero," "c" = "cipher"

After the consonant sounds representing each digit have been thoroughly learned, the Phonetic System can then be used in two general ways: (1) Keywords can be constructed to serve as a mental filing system; and (2) any numerical information can be coded into words to make it easier to learn. Numerous examples of this use are presented in most popular memory books (e.g., Lorayne & Lucas, 1974). Let us briefly consider the first use, because it parallels the use of the Loci and Peg Systems.

The Phonetic System can be used to construct key words to serve as a mental filing system. The key words serve as the mental filing system. They are used in the same way as the locations are used in the Loci System, and the peg-words are used in the Peg System.

The key words are constructed by combining vowels with the consonants. For example, there are many words that could represent the number "1": doe, day, die, tie, toe, tea, eat, hat, head, wade, etc.

It has been noted that one problem with the Peg System is that rhyming or look-alike nouns are hard to find for numbers beyond 10, and even harder for numbers beyond 20. Thus, it is difficult to construct pegwords for numbers beyond 10-20. The Phonetic System does not have this limitation. Two-digit numbers are represented by a word that begins with a consonant sound representing the first digit and ends with a consonant sound representing the second digit. For example, the number "13" could be represented by "tomb," "dome," or "dime," and the number "25" could be represented by "nail," "Nile," or "kneel." The procedure for three-digit numbers is the same; for "145" you could use "trial," "drill," or "twirl." However, numbers of more than two digits are sometimes difficult to represent by a single word, and may require two words, or a phrase. For example, 839 may be represented by "ivy fob," and 8890 by "five apes."

Research on the Phonetic System

Less research has been done on the Phonetic System than on the Link, Loci, and Peg Systems, for the obvious reason that it takes more time and effort to master the Phonetic System before it can be used. Thus, it is harder for a researcher to teach a group of people the system and have them use it in an experiment. Nevertheless, a few studies have investigated the effectiveness of the Phonetic System.

Three studies during the 1960s studied the effect of the Phonetic System on rate of learning. The first study found that people using phonetic keywords learned faster than a control group for lists of medium meaningfulness, a little faster for lists of low meaningfulness, and no faster for lists of high meaningfulness (Smith & Noble, 1965). This study does not give very strong support to the contention that the Phonetic System aids learning. However, several procedural factors may have affected this finding: (1) There was no check on whether the people who were taught the Phonetic System actually used the system in the experiment; (2) the items were presented at a rate of 4 seconds per item, which may have been too fast to recall the key word and associate it with the item; and (3) the lists contained only 10 words, which may not have been enough to tax the memories of the people who did not use the Phonetic System.

A second study on the rate of learning used longer lists (20 items rather than 10), and presented each item for a longer time (12 seconds rather than 4 seconds). Otherwise, the procedure was similar to that of the first study. Contrary to the findings of the first study, this second study found that the people who used the Phonetic System learned both kinds of items faster than those who did not use it. In fact, the Phonetic group learned the meaningless items as easily as the control group learned the meaningful items (Senter & Hauser, 1968).

The third study (Berla, Persensky, & Senter, 1969) related the Phonetic System to rate of learning of concrete nouns, and found results

consistent with the second study; the Phonetic System yielded a significant increase in rate of learning.

Persensky and Senter (1969) investigated the effect of the Phonetic System on retention as well as learning. People learned three consecutive lists of 20 words each. They were tested for recall of the words in numerical order immediately after each list had been presented, and again after all three lists had been presented. In immediate recall, the Phonetic groups recalled an average of about half the words, while the recall of the control group ranged from 20-40%. In recall at the end of the session, the Phonetic groups averaged about 40% recall while the controls averaged about 19%.

In a study which used a slightly different procedure from those discussed so far in this section, people were given a printed list of 25 Phonetic key words to use in learning two consecutive 25-item lists, and were trained in making visual associations with the key words. They showed an average recall of about 60%, while a control group showed an average recall of about 19% (Persensky & Senter, 1970).

Foth (1973) investigated three of the mnemonic systems in one study. Different groups of people were taught ten pegwords, ten key words, or ten numbered loci as parts of an automobile. They were then read five lists of 10 numbered nouns, and tested for recall. All three mnemonic systems resulted in increased recall of concrete nouns, as compared with control groups. However, none of the three systems increased recall for abstract nouns. There were no significant differences among the three systems.

Slak (1970) devised his own letter-number system to learn 3-digit numbers. The first and third digits were represented by consonants and the middle digit was represented by a vowel. Slak reported that the system helped him in a memory span task, in serial learning, and in free learning. He also taught a simplified version of the system to a group of people who used it to learn eight 3-digit numbers. The group learned the numbers twice as fast as a group that had not been taught the system; they required an average of about 6½ presentations of the numbers before they could recall all of them once without error, while the other group required an average of 14 presentations.

The use of the Phonetic System by students in my memory course provides a different kind of evidence from that provided by the research studies; it involves a within-group comparison rather than a between-groups comparison. At the first class meeting, I read to the students a list of 20 numbered nouns in random order, and have them recall as many as they can recall in correct numbered order. Later in the course, after we have discussed the Phonetic System, I give them the same task with another 20-noun list. The 62 students in my three most recent classes recalled a mean of 10.2 words before learning the Phonetic System and 18.9 words after learning it. Their recall performance

before and after they learned the Phonetic System is summarized in Table 2 (the student who recalled only two words before learning the system was among the 56% who recalled all 20 words after learning it).

Table 2

Number of People Recalling Each Number of Words Before and After Learning the Phonetic System

Number of Words Recalled	Before Phonetic	After Phonetic
20	1	35
19	1	13
18	2	6
17	2	1
16	3	1
15	3	2
14	4	2
13	4	1
12	4	1
11	4	
10	6	
9	5	
8	3	
7	4	
6	5	
5	5	
4	3	
3	2	
2	1	

Summary and Conclusions

While mnemonic systems have been taught and used for hundreds of years, psychologists have only recently shown interest in investigating the systems experimentally. Virtually all of the experimental research on mnemonic systems has been conducted since 1965.

In this paper, four mnemonic systems were described, and research conducted on each system was briefly summarized. All of the systems rely heavily on visual imagery. The Link System (and closely-related Story System), the simplest of the systems, aids serial recall by associating items with each other in a chain of associations. The Loci System, the most ancient of the systems, aids recall by associating items with pre-memorized mental images of locations (loci). The Peg

System aids recall by associating items with a pre-memorized series of concrete nouns (pegwords). The Phonetic System, the most complex of the systems, substitutes consonant sounds for digits to allow for coding numbers into words and for constructing extensive lists of key words to be used in the same manner the loci and pegwords are used.

The conclusion suggested by the relevant research on these systems is that mnemonic systems can make enough of a contribution to memory to warrant mastering their use and continuing to conduct research on them. Mnemonic systems <u>are</u> worth the effort.

References

Berla, E., Persensky, J. J., & Senter, R. J. Learning time with a mnemonic system. Psychonomic Science, 1969, 16, 207-208.

Blick, K. A., & Waite, C. J. A survey of mnemonic techniques used by college students in free-recall learning. Psychological Reports, 1971, 29, 76-78.

Boltwood, C. E., & Blick, K. A. The delineation and application of three mnemonic techniques. Psychonomic Science, 1970, 20, 339-341.

Bower, G. H. Analysis of a mnemonic device. American Scientist, 58, 1970, 496-510.

Bower, G. H. A selective review of organizational factors in memory. In E. Tulving & W. Donaldson (Eds.), Organization and memory. New York: Academic Press, 1972, 93-137. (a)

Bower, G. H. Mental imagery and associative learning. In L. W. Gregg (Ed.), Cognition in learning and memory. New York: John Wiley & Sons, Inc., 1972, 51-88. (b)

Bower, G. H. How to...uh...remember! Psychology Today, October, 1973, 63-70.

Bower, G. H., & Clark, M. C. Narrative stories as mediators for serial learning. Psychonomic Science, 1969, 14, 181-182.

Bower, G. H., & Reitman, J. S. Mnemonic elaboration in multilist learning. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 478-485.

Briggs, G. G., Hawkins, S., & Crovitz, H. F. Bizarre images in artificial memory. Psychonomic Science, 1970, 19, 353-354.

Brown, A. L. Mnemonic elaboration and recency judgments in children. Cognitive Psychology, 1973, 5, 233-248.

Bugelski, B. R. Images as mediators in one-trial paired-associate learning. II: Self-timing in successive lists. Journal of Experimental Psychology, 1968, 77, 328-334.

Bugelski, B. R. Words and things and images. American Psychologist, 1970, 25, 1002-1012.

Bugelski, B. R. The image as mediator in one-trial paired-associate learning: III: Sequential functions in serial lists. Journal of Experimental Psychology, 1974, 103, 298-303.

Bugelski, B. R., Kidd, E., & Segman, J. The image as a mediator in one-trial paired-associate learning. Journal of Experimental Psychology, 1968, 76, 69-73.

Byrne, B. Item concreteness vs. spatial organization as predictors of visual imagery. Memory and Cognition, 1974, 2, 53-59.

Crovitz, H. F. Memory loci in artificial memory. Psychonomic Science, 1969, 82-83.

Crovitz, H. F. Mnemonics and the total-time hypothesis. Paper presented at the meeting of the Psychonomic Society, Denver, November, 1975.

Delin, P. S. Learning and retention of English words with successive approximations to a complex mnemonic instruction. Psychonomic Science, 1969, 17, 87-89. (a)

Delin, P. S. The effects of mnemonic instruction and list length on serial learning and retention. Psychonomic Science, 1969, 17, 111-113. (b)

Delin, P. S. The learning to criterion of a serial list with and without mnemonic instruction. Psychonomic Science, 1969, 16, 169-170. (c)

Delprato, D. J., & Baker, E. J. Concreteness of pegwords in two mnemonic systems. Journal of Experimental Psychology, 1974, 102, 520-522.

DiVesta, F. J., & Sunshine, P. M. The retrieval of abstract and concrete materials as functions of imagery, mediation, and mnemonic aids. Memory and Cognition, 1974, 2, 340-344.

Feinaigle, M. G. von: The new art of memory. 2nd ed. London: Sherwood, Neely, & Jones, 1813.

Foth, D. L. Mnemonic technique effectiveness as a function of word abstractness and mediation instruction. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 239-245.

Groninger, L. D. Mnemonic imagery and forgetting. Psychonomic Science, 1971, 23, 161-163.

Groninger, L. D. Imagery and subjective categorization effects on long-term recognition and retrieval. Bulletin of the Psychonomic Society, 1974, 3, 261-263.

Higbee, K. L. A century of research on mnemonics: We're back where we started. Paper presented at the meeting of the Western Psychological Association, Los Angeles, April 1976. (a)

Higbee, K. L. Can young children use mnemonics? Psychological Reports, 1976, 38, 18. (b)

Hunter, I. M. L. Memory (Revised). Middlesex, England: Penguin Books, Ltd., 1964.

James, W. Principles of psychology. Vol. I.. New York: Holt, 1890.

Kobasigawa, A. Effects of retrieval cues on children's recall following free- or cued-recall instructions. Perceptual and Motor Skills, 1975, 40, 187-191.

Lea, G. Chronometric analysis of the method of loci. Journal of Experimental Psychology: Human perception and Performance, 1975, 104, 95-104.

Lorayne, H., & Lucas, J. The memory book. New York: Stein & Day, 1974. (published in paperback by Ballantine Books, 1975).

Manning, B. A., & Bruning, R. H. Interactive effects of mnemonic techniques and word-list characteristics. Psychological Reports, 1975, 36, 727-736.

McKellar, P., Marks, D. F., & Barron, B. F. The mnemonic walk and visual imagery differences. Cited by Marks, D. F., "Individual differences in the vividness of visual imagery and their effect on function," in P. W. Sheehan (Ed.), The function and nature of imagery. New York: Academic Press, 1972, 83-108.

Mueller, J. H., & Jablonski, E. M. Instructions, noun imagery, and priority in free recall. Psychological Reports, 1970, 27, 559-566.

Murray, F. S. Effects of narrative stories on recall. Bulletin of the Psychonomic Society, 1974, 4, 577-579.

Paivio, A. Effects of imagery instructions and concreteness of memory pegs in a mnemonic system. Paper presented at the meeting of the American Psychological Association, 1968. (Described in A. Paivio, Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971, pp. 341-342.)

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971.

Persensky, J. J., & Senter, R. J. An experimental investigation of a mnemonic system in recall. The Psychological Record, 1969, 19, 491-499.

Persensky, J. J., & Senter, R. J. An investigation of "bizarre" imagery as a mnemonic device. The Psychological Record, 1970, 20, 145-150.

Read, J. D., & Peterson, R. H. Individual differences in the ease of imagining the faces of others. Bulletin of the Psychonomic Society, 1975, 5, 347-349.

Roberts, W. A. Alphabetic coding and individual differences in modes of organization in free-recall learning. American Journal of Psychology. 1968, 81, 433-438.

Ross, J., & Lawrence, K. A. Some observations on memory artifice. Psychonomic Science, 1968, 13, 107-108.

Russell, J. J. Mental elaboration and cognitive performance. The Journal of Negro Education, 1974, 43, 202-211.

Schulman, A. I. Recognition memory and the recall of spatial location. Memory and Cognition, 1973, 1, 245-260.

Senter, R. J., & Hauser, G. K. An experimental study of a mnemonic system. Psychonomic Science, 1968, 10, 289-290.

Slak, S. Phonemic recoding of digital information. Journal of Experimental Psychology, 1970, 86, 398-406.

Smith, R. K., & Noble, C. E. Effects of a mnemonic technique applied to verbal learning and memory. Perceptual and Motor Skills, 1965, 21, 123-134.

Von Wright, J. M., Gebhard, P., & Karttunen, M. A developmental study of the recall of spatial location. Journal of Experimental Child Psychology, 1975, 20, 181-190.

Wood, G. Mnemonic systems in recall. Journal of Educational Psychology, 1967, 58, 1-27.

Yarmey, A. D. I recognize your face but I can't remember your name: Further evidence on the tip-of-the-tongue phenomenon. Memory and Cognition, 1973, 1, 287-290.

Yates, F. A. The art of memory. London: Routledge and Kegan Paul, Ltd., 1966.

Zechmeister, E. B., McKillip, J., Pasko, S., & Bespalec, D. Visual memory for place on the page. Journal of General Psychology, 1975, 92, 43-52.